APPENDIX D

LAX Shoreline Monitoring Report

SANTA MONICA BAY SHORELINE MONITORING
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REPORT
(June 1, 2012 – May 31, 2013)
Monitoring and Assessment by the City of Los Angeles Environmental Monitoring Division

I. INTRODUCTION

Increasing population and ongoing urban developments within the Santa Monica Bay area have the potential to create significant impacts on beach water quality. Human activities, including, but not limited to, car washing, landscape irrigation, neglecting to pick up and properly dispose of pet waste, homelessness, improper disposal of car oil, illicit connections, and leaky septic tanks, contribute various pollutants that are washed into local waters through storm drains and urban runoff especially during rain events. These are considered as point and non-point sources of pollutants. These sources contain flows that are untreated. Significant improvements have been made in treating point source flows from wastewater treatment plants and industrial facilities, the Environmental Protection Agency (EPA) has estimated that non-point sources of pollution is now the single largest cause of deterioration of water quality (Ohio State University 2009; Dojiri et al., 2003). Storm drains have been identified as potentially large sources of bacteria discharged to receiving waters around the country. This is particularly true in California, where sanitary sewer and storm drain sewer systems are separate, and storm drain discharges are not treated before they discharge across the beach directly into the water-contact zones (Schiff and Kinney 2001).

The EPA established a municipal storm water management program known as the Municipal Separate Storm Sewage System (MS4) Program that is intended to improve the nation's waters by reducing the quantities of pollutants that urban runoff and storm water pick up and carry into the storm water systems from normal or routine urban activities and during storm events. An MS4 is a conveyance system made up of catch basins, curbs, gutters, ditches, and storm drains owned by a state, city, county, town, or other public body, that is designed to collect or convey storm water and urban runoff to waters of the US (CRWQCB 2001). Unless diverted to treatment plants or other treatment facilities, these discharges are untreated, carrying pollutants to local water bodies. The City of Los Angeles (CLA), as a co-permitee of the Los Angeles County MS4 Program, discharges storm water into local waterways. The permit for the MS4 Program requires the City to design a storm water management program that reduces the discharge of pollutants to the maximum extent practicable, that protects water quality, and that satisfies the water quality requirements of the Clean Water Act (CRWQCB 2001).

The Santa Monica Bay Beaches were designated as impaired and included on California's 1998 Clean Water Act 303(d) list of impaired waters due to excessive amounts of coliform bacteria. The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) released a first draft of the Santa Monica Bay Beaches Bacterial TMDL (SMBBB TMDL) on November 9, 2001. Regional Board staff bifurcated the SMBBB TMDL into two TMDLs, one for dry-weather and one for wet-weather. Both the SMBBB Dry- and Wet-Weather TMDLs were approved by EPA in June 2003 and became effective on July 15, 2003. The SMBBB TMDLs divide the year into three separate periods for compliance purposes: summer-dry weather (April 1 – October 31), winter-dry weather (November 1 – March 31), and wet weather. A single Coordinated Shoreline Monitoring Plan (CSMP) was developed by the TMDL's responsible agencies to comply with the monitoring requirements of both the Dry- and Wet-Weather TMDLs; monitoring of SMBBB TMDL compliance monitoring stations began November 1, 2004. In addition to bacterial monitoring sites, the CSMP established multiple shoreline observation sites for dry-weather flow observations. One year from the initiation of the monitoring program, the Regional Board was to evaluate the accumulated flow observation data to determine whether any of the observation sites warranted inclusion to the list of compliance monitoring sites.

Four years after the effective date of the TMDLs, the Regional Board was to have re-opened the TMDLs to reconsider certain provisions based on new data, including waste load allocations. Waste load allocations are the number of sample days at a shoreline sampling site that may exceed a single-sample target. Waste load allocations are expressed as allowable exceedance days because the bacterial density and frequency of single-sample exceedances are the most relevant to public health protection (CRWQCB 2004).

Current state water quality standards require the use of bacteria as indicators of human fecal contamination. Their presence in water, especially fecal coliform/*E. coli* and enterococci, is considered to be an indication of recent fecal contamination, which is the major source of many waterborne diseases (Csuros and Csuros 1999).

The SMBBB TMDLs establish multi-part numeric targets based on three bacteriological analytical parameters: Total coliform density, fecal coliform/*E. coli* density, and *Enterococcus* density, with density reported in bacterial counts per 100 milliliters. The targets instituted by the TMDLs have been established based on the Los Angeles Basin Plan water quality objectives for water contact recreation (REC-1) beneficial use for marine water and are equivalent to the State bacteriological standards pursuant to Assembly Bill 411. Basin Plan objectives include both single-sample limits and geometric mean limits (Table 1). EMD evaluates and reports data relative to marine water REC-1 water quality standards for bacterial densities.

Table 1. Los Angeles Basin Plan bacteriological water quality standards (REC-1)

Single Sample Limits shall not exceed	**Rolling 30-day Geometric Mean Limits shall not exceed**
10,000 total coliform bacteria/100 ml; or	1,000 total coliform bacteria/100 ml; or
400 fecal coliform/*E.coli* bacteria/100 ml; or	200 fecal coliform/*E.coli* bacteria/100 ml; or
104 *Enterococcus* bacteria/100 ml; or	35 *Enterococcus* bacteria/100 ml
1,000 total coliform bacteria/100 ml, if the ratio of fecal/total coliform exceeds 0.1	

Monitoring indicator bacteria, currently, is one of the most efficient means of predicting the presence of pathogens in marine waters. These indicators are used because the methods for their detection are comparatively rapid, relatively inexpensive, and easy to perform. The current quantification method used to quantify indicator bacterial densities for all SMB shoreline stations, the chromogenic substrate method (CS), depends on approximately an 18 to 24 hour incubation and bacterial growth period to obtain results. The turnaround time of this and other currently employed quantification methods prevent early notification of potential public health risks and contamination source identifications.

As part of the Annual Report for the MS4 NPDES Permit, CLA had been submitting a Santa Monica Bay Shoreline Monitoring Annual Report that included water quality analysis at eighteen (18) MS4 monitoring stations over the period from July 1 through June 30. The time between the end of the reporting period date June 30 and the submittal deadline was not sufficient for lab analysis, data compilation, data analysis, and preparation of the final report. CLA requested and received approval from the Regional Board to modify the reporting period from July 1 through June 30 to **June 1 thru May 31**. This report summarizes the City of Los Angeles EMD's Santa Monica Bay shoreline bacteriological data for the Reporting Year 2012-2013 (June 1, 2012 through May 31, 2013).

The Santa Monica Bay shoreline bacterial data collected by CLA are reported daily to the Los Angeles County Department of Public Health (LACDPH). Subsequently, LACDPH takes steps (such as posting health hazard warning signs for beach users) to notify beach goers whenever an exceedance of bacterial standards occurs.

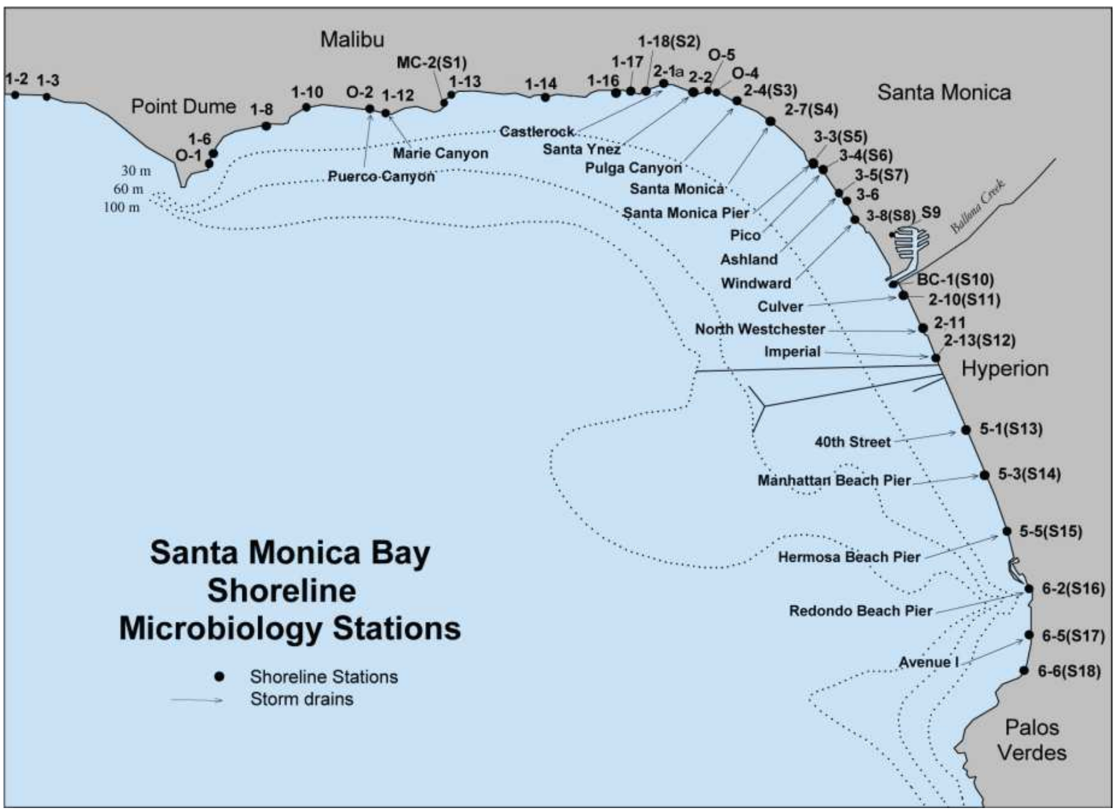

Figure 1: Map of EMD shoreline sampling locations in Santa Monica Bay, including storm drains and piers. Table 2 provides a complete list of station names and their corresponding MS4 and/or SMBBB TMDL station identification.

II. MATERIALS AND METHODS

Sample Collection

Historically, EMD monitored eighteen MS4, SMB shoreline stations ranging from Surfrider Beach (S1, Malibu Lagoon) in Malibu southward to Malaga Cove (S18, Palos Verdes Estates; Figure 1). On November 1, 2004, CLA EMD began participating in the Coordinated Shoreline Monitoring Plan (CSMP) for the Santa Monica Bay Beaches Bacterial TMDLs (SMBBB TMDL), monitoring 25 SMBBB TMDL compliance stations ranging from El Pescador State Beach in Malibu (1-2) southward to Dockweiler State Beach (stations BC-1 through 2-13). In addition to the compliance sampling sites, the CSMP established that CLA EMD would record weekly, dry-weather flow observations at five observation sites with the caveat that after a year of observations, the Regional Board would determine whether these sites would warrant being added to the list of compliance water quality sites, based on observations of persistent dry-weather runoff.

The CSMP and the Memoranda of Agreement reached between CLA and the other SMBBB TMDL responsible agencies established that CLA was responsible for monitoring 7 compliance stations solely as MS4 stations, 16 compliance stations solely as SMBBB TMDL stations, and 11 compliance stations as both MS4 and SMBBB TMDL sites, e.g., Malibu Creek at Surfrider Beach is both S1 and MC-2 for MS4 and SMBBB TMDL compliance monitoring, respectively (Table 2). MS4 and SMBBB TMDL stations are monitored either daily (Monday – Saturday) or weekly. In addition to adopting some MS4 stations as TMDL stations, some TMDL monitoring requirements were incorporated into the MS4 permit. Accelerated monitoring of weekly monitored TMDL stations is conducted 48 hours after the initial sample exceeds bacterial standards and 96 hours for sites that again exceed bacterial limits.

CLA submitted a request to the Regional Board in September of 2009 petitioning the upgrading of two observation stations with persistent runoff and either the removal or re-location of sampling locations that were consistently inaccessible to sampling and/or observations. In December 2009, the Regional Board approved CLA's proposed changes. Observation stations O-1 (Zumirez Dr, Point Dume) and O-2 (Puerco Canyon SD, Puerco Beach) were upgraded to bacterial water quality monitoring stations based on persistent runoff and accessibility; station O-3 (Pierda Gorda, 36" SD) was removed as an observation site due to its continued inaccessibility. In addition, as a consequence of constant inaccessibility and a safety concern to field personnel, 2-1 (Castlerock SD) was relocated from point zero to just north of the storm drain where it is accessible and safe to sample. It was re-designated 2-1a to reflect the change in sampling point. The approved changes became effective January 2010, and EMD began sampling 27 SMBBB TMDL compliance monitoring stations and continued recording dry-weather flow observations at the two remaining observation sites: O-4 and O-5.

With the exception of a few sites, all shoreline stations are sampled at point zero, which is defined as the point at which the discharge from a storm drain or creek initially mixes with the receiving water. A station having no storm drain or creek associated with it is referred to as an open beach site and is sampled at the midpoint of the beach (CSMP 2004). Station 2-1

(Castlerock SD), which was relocated from point zero to just north of the storm drain in January 2010, also, is not sampled at point zero.

Station Name	SMBBB TMDL	MS4	Frequency	Station Name	SMBBB TMDL	MS4	Frequency
El Pescador SB	1-2		NS	Santa Monica Pier SD, Santa Monica SB	3-3	S5	Daily
El Matador SB	1-3		Weekly	Pico-Kenter SD, Santa Monica SB	3-4	S6	Daily
Zumirez Dr, Point Dume	O-1		Weekly	Ashland SD, Santa Monica SB	3-5	S7	Daily
Walnut Creek, Paradise Cove	1-6		Weekly	Rose Ave SD, Venice Bch	3-6		Weekly
Escondido Crk, Escondido SB	1-8		Weekly	Windward Ave SD, Venice Bch	3-8	S8	Weekly
Solstice Crk, Dan Blocker County Bch	1-10		Weekly	Marina del Rey Bch, MDR		S9	Daily
Marie Cyn SD, Puerco Bch	1-12		Weekly	Ballona Creek, Dockweiler SB	BC-1	S10	Daily
Puerco Canyon SD, Puerco Bch	O-2		Weekly	Culver SD, Dockweiler SB	2-10	S11	Weekly
Malibu Crk, Malibu Lagoon County Bch	MC-2	S1	Daily	North Westchester SD, Dockweiler SB	2-11		Weekly
Sweetwater Cyn SD, Carbon Bch	1-13		Weekly	Imperial Hwy SD, Dockweiler SB	2-13	S12	Weekly
Las Flores Crk, Las Flores SB	1-14		Weekly	40th Street, Manhattan Bch		S13	Weekly
Pena Crk, Las Tunas County Bch	1-16		Weekly	Manhattan Bch Pier		S14	Weekly
Tuna Cyn, Las Tunas County Bch	1-17		Weekly	Hermosa Bch Pier		S15	Weekly
Topanga Cyn, Topanga County Bch	1-18	S2	Daily	Redondo Bch Pier		S16	Daily
Castlerock SD, Topanga County Bch	2-1a		Weekly	Avenue I SD, Redondo Bch		S17	Weekly
Santa Ynez SD, Will Rogers SB	2-2		Weekly	Malaga Cove, Palos Verdes Estates		S18	Weekly
Pulga Cyn SD, Will Rogers SB	2-4	S3	Weekly	24" corrugated metal pipe near O-5	O-4		Weekly
Santa Monica Cyn SD, Santa Monica SB	2-7	S4	Daily	Marquez SD, Santa Ynez subwatershed	O-5		Weekly

Table 2. Summary of CLA EMD's bacterial compliance monitoring stations in Santa Monica Bay with corresponding MS4 and/or SMBBB TMDL station identification. Sampling frequency is daily or weekly; NS = not sampled. Sampling at El Pescador State Beach (1-2) ceased due to safety concerns; sampling will resume when safety issues are resolved. Stations SMB-O-4 and O-5 are monitored only as dry-weather flow observations sites.

All samples were collected at ankle-depth during daylight hours, with the exception of station 2-2. Accessing 2-2 is difficult; there is a tall fence surrounding the storm drain, large boulders in both directions, and a “Keep off Rocks” sign. Sampling is attainable from the top of the storm drain, but a point zero (mixed) sample can be collected only at high tide. The location of station 1-17 poses an accessibility obstacle as it is reachable only through a very narrow stretch of private beach; during high tide and/or when rocks pose a safety risk to field personnel, this site is inaccessible. In September 2011, sampling at El Pescador State Beach (1-2) ceased due to safety concerns to field personnel; sampling will resume when safety issues, such as eroding and unstable terrain, are resolved.

Because of spatial, logistical, and time constraints, simultaneous sample collection (within a 3 – 4 hour period) of SMB TMDL and MS4 stations is divided into northern stations, from 1-2 (El Pescador State Beach) to 1-16 (Pena Creek), central stations, from 1-17 (Tuna Canyon) to S9 (Mother’s Beach) in Marina Del Rey, and southern stations, S10 (BC-1, Ballona Creek) to S18 (Malaga Cove) in Palos Verdes Estates.

For FY2012-2013, 3,467 samples were collected for the MS4 and SMBBB TMDL Programs combined.

Sample Analysis

Total coliform (TC) and *E. coli* (EC) bacterial densities were determined by the chromogenic substrate method following Standard Methods section 9223 (APHA 1998), and *Enterococcus*

(ENT) densities were determined by Enterolert™, per manufacturer's instructions. Fecal indicator bacterial analyses totaling 10,401 were performed during the 2012 – 2013 fiscal year.

Visual field observations for shoreline stations were made along a 20-foot stretch of shoreline up and down coast of each station. This area around each station was observed for the presence of materials of sewage and non-sewage origin, any unusual odors of sewage and non-sewage origin, plankton color, and the presence of flow and flow rate (visual rating only) from storm drains and creeks. Storm drain flow data and Low-Flow Diversion structures operation information is available upon request. Materials of sewage origin include plastic goods, rubber goods, and grease particles. Non-sewage origin materials include ocean debris, seaweed, refuse, tar, and dead marine animals. Station 3-5 (S7, Ashland SD, Santa Monica State Beach) was used as the shoreline weather station for observations of air and water temperature, weather conditions, wind speed and direction, wave height, and sea conditions.

Quality assurance and quality control procedures were conducted to confirm the validity of the analytical data collected. All areas impacting reported data were subjected to standard microbiological quality control procedures in accordance with Standard Methods (APHA 1998). These areas include sampling techniques, sample storage and holding time, facilities, personnel, equipment, supplies, media, and analytical test procedures. Duplicate analyses also were performed on ten percent of all samples. When quality control results were not within acceptable limits, corrective action was taken. This quality assurance program helped ensure the production of uniformly high quality and defensible data. In addition, EMD participates annually in the performance evaluation program managed by the California State Department of Public Health (CSDPH) as part of its Environmental Laboratory Accreditation Program (ELAP); CSDPH biennially certifies EMD.

Data Analysis

The results obtained from microbiological samples do not generally exhibit a normal distribution. To compensate for a skewed distribution and to obtain a nearly normal distribution, data was be log-normalized prior to analysis. Geometric means are the best estimate of central tendency for log-normalized data and were calculated for each bacterial indicator group for all sampling sites. Geometric means were categorized into summer-dry, winter-dry, and wet-weather to examine the effects of runoff from storm drains on indicator bacterial concentrations.

The geometric mean is defined in Webster's Dictionary as "the n^{th} root of the product of n numbers." The SMBBB TMDL rolling 30-day geometric mean was calculated as the 30^{th} root of the product of 30 numbers (the most recent 30-day results). For weekly sampling, the 30 numbers are obtained by assigning the weekly test result to the remaining days of the week. If more samples are tested within the same week, each test result superseded the previous result and was assigned to the remaining days of the week until the next sample was collected. A rolling 30-day geometric mean was calculated for each day, regardless of whether a weekly or daily schedule was selected, during summer-dry and winter-dry periods.

The SMBBB TMDLs define wet-weather as days with rain events of ≥ 0.1 inch of precipitation and the three days following the end of the rain event. Rain data were obtained from the National Weather Service's Downtown Los Angeles, University of Southern California (USC) records.

III. Results

Rainfall

Rainfall recorded during Fiscal Year 2012-2013 totaled 5.84 inches, which is less than FY 2011-2012 (8.68 inches) and well below the seasonal average (15.14 inches) for the Los Angeles area. This also was the second lowest rainfall year for the region in the last ten years. November 2012 to March 2013 were the primary months of rainfall for the FY 2012-2013 with May 2013, surprisingly, registering 0.71 inches of rain. Three months, from November to January, had the most rainfall totaling 4.37 inches. December received the highest rainfall (2.16 inches) and October had the lowest measureable precipitation (0.02 inch) for this reporting period. No rain was recorded for the months from June through September 2012 and April 2013 (Figure 2).

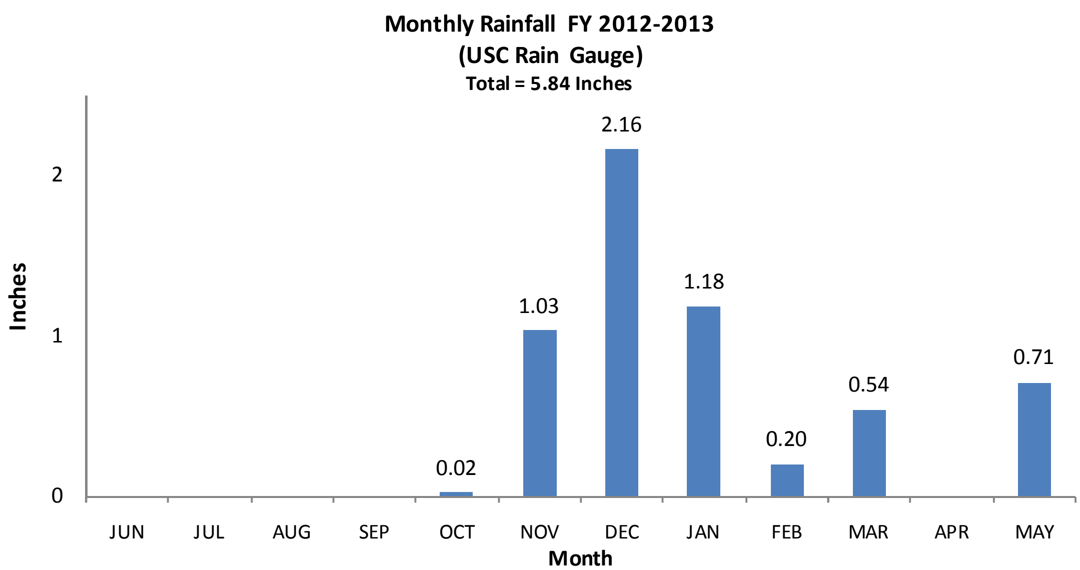

Figure 2. Monthly rainfall at Downtown Los Angeles, USC, June 2012 – May 2013.

Shoreline Monitoring Stations

Sample collection from Santa Monica Bay compliance monitoring stations is conducted year round to assess water quality. Bacterial densities obtained from fiscal year 2012-2013 were computed and graphed for geometric mean values for summer-dry, winter-dry, and wet-weather. Graphical representations of geometric mean values per monitoring site for each time period are illustrated in Figures 3, 4, and 5. The incorporation of sixteen SMBBB TMDL stations, in addition to the 18 historical SMB MS4 sites, variations and significant geometric mean observations are presented below.

Summer-Dry Weather (Jun 2012 – Oct 2012; Apr 2013 – May2013)

The highest geometric means, overall, for indicator bacteria during summer-dry periods were recorded at stations 3-3 (S5, Santa Monica Pier), S16 (Redondo Beach Pier), and 1-12 (Marie Canyon); to a lesser degree, stations 2-2 (Santa Ynez SD), MC-2 (S1, Malibu Creek), 1-13 (Sweetwater Canyon) and 1-10 (Solstice Creek) also recorded high geometric means (Figure 3). The southern bay station BC-1 (S10, Ballona Creek) registered the highest total coliform geometric mean. The two sites with the highest calculated *E. coli* densities, 3-3 (S5) and 1-17 (Tuna Canyon SD), are located in central Santa Monica Bay. Central bay station 3-3 (S5) and southern bay station S16 recorded the highest Enterococcus geometric mean. Compared to FY 11-12 summer-dry periods, FY 12-13 summer-dry weather recorded lower densities for all three fecal indicator bacteria.

Although Figure 3 indicates weekly monitored station 1-17 had the second highest densities for *E. coli* during summer-dry weather, this site was collected only 3 days during this period compared to 30 and 150 sample days for weekly and daily monitoring stations, respectively. Sampling Tuna Canyon SD (1-17) is dependent on tide height; the site is periodically inaccessible during high tide and/or when rocks pose a safety risk to field personnel. A higher number of samples would have produced a better representation of the FIB water quality of station 1-17. In the absence of additional samples it is difficult to predict how the geometric mean would have been affected.

Winter-Dry Weather (November 1, 2012 to March 30, 2013)

High geometric means of bacterial indicators measured for the winter-dry weather were predominately at stations MC-2 (S1), 2-2, 3-3 (S5), S9, and S16 (Figure 4). All five stations registered high geometric mean for total coliform density. Only stations 3-3 (S5) and S16 registered high densities for *E. coli*. Stations 2-2, S9, and S16 were sites with the highest Enterococcus densities.

Overall, stations 2-2, 3-3 (S5), and S16 registered some of the highest geometric mean levels of bacterial indicators for the winter-dry period. Located in the central Bay, station 2-2 had the highest geometric mean for total coliform and the second highest for enterococcus. Also from the central Bay, station 3-3 (S5) registered the highest *E. coli* density and the third highest total coliform density. Station S16 recorded high geometric mean for all three bacterial indicators, ranking the highest for Enterococcus density in addition to the second highest *E. coli* geometric mean. Similar to *E. coli* densities found at station 1-17 during summer-dry weather, weekly monitored station 2-2 had the highest densities for total coliform during winter dry-weather in spite of a lower sample count; nine samples compared to 14 and 79 samples for weekly and daily monitored sites, respectively. Santa Ynez SD (2-2) is one of the sites that is frequently inaccessible to sampling; fluctuating tides and the safety to field personnel limited sample collection frequency. Although the nine samples met the minimum five data points required to calculate a statistically reliable geometric mean, a higher sample count could have produced a more comparable representation of station 2-2 water quality conditions.

Geometric means for the northern stations were relatively low. Only a moderate geomean level of total coliform was observed at station 1-10. Winter-dry geometric means were in general greater than summer-dry geometric means.

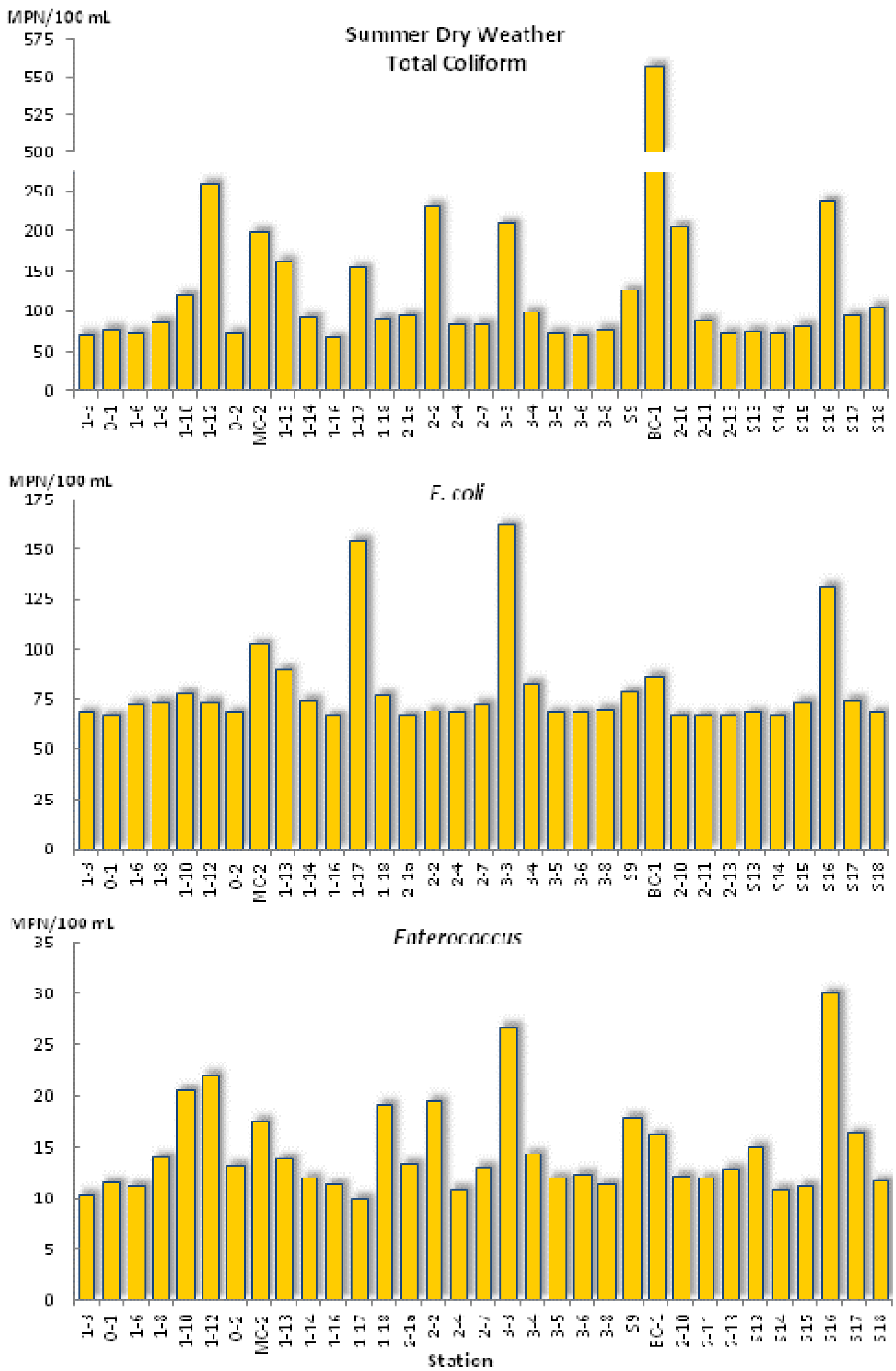

Figure 3. Summer-dry weather geometric means for indicator bacteria at compliance monitoring stations in Santa Monica Bay, FY 2012-2013.

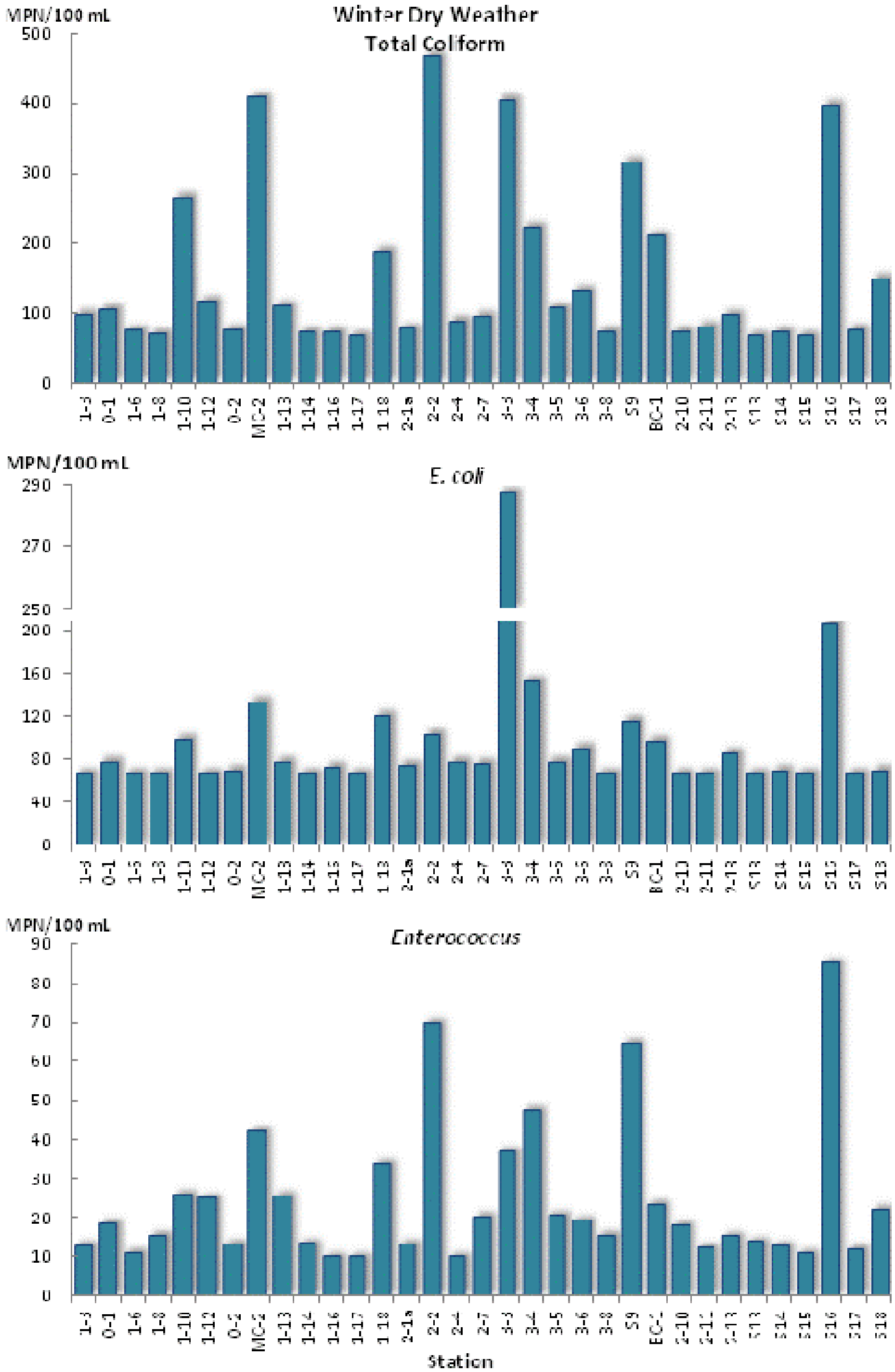

Figure 4. Winter-dry weather geometric means for indicator bacteria at compliance monitoring stations in Santa Monica Bay, FY 2012-2013.

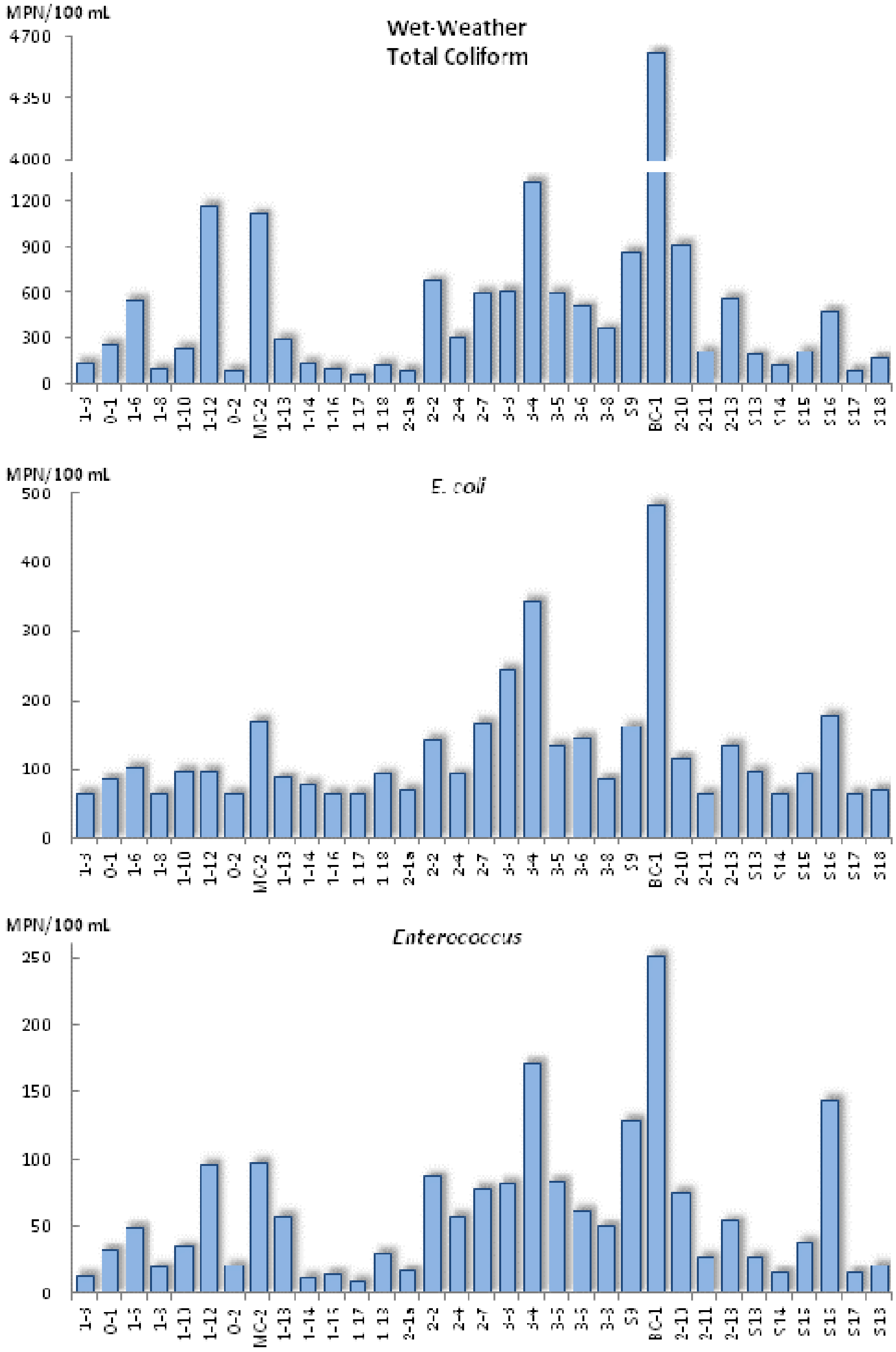

Figure 5. Wet-weather geometric means for indicator bacteria at compliance monitoring stations in Santa Monica Bay, FY 2012-2013.

Wet-Weather (Day of rain with 0.1 inches of rainfall plus three succeeding days)

Geometric means computed for compliance stations during wet-weather are graphically illustrated in Figure 5. Station BC-1 (S10) and 3-4 (S6) had the highest and second highest densities, respectively, for all three bacterial indicators during wet-weather periods. Total coliform densities at BC-1 (S10) were more than triple the densities observed at other stations. Stations 1-12, MC-2 (S1), 3-3 (S5), S9, and S16 were among sites with moderate to high geometric mean levels compared to the remaining stations.

The overall geometric means recorded for wet-weather periods (Figure 5) were typically higher compared to the dry-weather periods. The majority of high bacterial indicator concentrations were detected in the central region of the Bay from stations 2-2 to BC-1 (S10). Stations MC-2 (S1) and S16 were sites with relatively high concentrations located in the northern and southern portions of the Bay, respectively. A stretch of sites from station 1-13 to 2-1a and 2-10 to S18, excluding S16, had low geometric mean levels for the wet-weather periods.

Water Quality Standards Compliance

Per the Santa Monica Bay Beaches Bacteria TMDL, allowable exceedances days assigned to each station is adjusted on the basis of the monitoring frequency; fewer exceedances are allocated for sites monitored weekly, compared to those that are monitored daily. During dry-weather periods when a weekly monitored station exceeds one of the water quality objectives (Table 1), accelerated monitoring is triggered, in which an additional sample is collected after 48 hours of the initial sampling event, and if the 48-hour sample also exceeds, another sample is collected after another 48 hours (or 96 hours after the initial weekly collection). No additional exceedance allowances were allocated for accelerated samples, and accelerated sample exceedances are not counted against the allowable exceedances. All exceedance days for daily monitored SMBBB TMDL sites are counted against the allowable exceedance days. SMBBB TMDL data assessment for stations S9 and S13 through S18 is not addressed in this report as CLA only conducts MS4 monitoring for these sites (Table 2). Data for these sites is assessed only for the MS4 permit and is not subject to the SMBBB TMDL waste load allocations and rolling 30-day geometric mean for the three weather periods.

The purpose of collecting shoreline samples and reporting bacterial densities is to determine compliance with the state bathing water standards and to assess water quality and the impact it may have on public health. In addition, when an exceedance of bacterial water quality standards occurs, the LACDPH takes steps to notify beach goers, such as posting health hazard warning signs. Los Angeles Basin Plan bacteriological objectives for REC-1 designation for FY 2012-2013 Santa Monica Bay shoreline stations collected by CLA EMD were examined and evaluated (Tables 3 to 6).

Summer-Dry Weather (Jun 2012 – Oct 2012; Apr 2013 – May 2013)

Of the 26 shoreline stations monitored for SMBBB TMDL compliance, 16 stations surpassed the single-sample waste load allocation (WLA) of zero allowable exceedances during the summer-dry period (Table 3), whereas only 9 stations surpassed the rolling, 30-day geometric mean limit of zero allowable exceedance days. Stations 3-3 (S5), MC-2 (S1), 1-18 (S2), and BC-1 (S10) had the highest TMDL single-sample exceedance days amongst the stations monitored daily; stations 1-12 and 1-10 had the highest single-sample TMDL exceedance days for weekly monitored stations. With the exception of station MC-2 (S1), all aforementioned TMDL stations had the highest rolling 30-day geometric-mean exceedance days. Analyzing the data in terms of single-sample exceedance rate (% exceedance), only two daily monitored TMDL stations had exceedance rate greater than 10%, 3-3 (S5) at 29% and MC-2(S1) at 12%. Weekly TMDL stations 1-12 and 1-10 had 13% and 10% exceedance rates.

Table 3. Summer-Dry Weather, FY 2012-2013 Exceedance Days

Station*	Sampling Frequency	Sample Days	Single-Sample Exceedance Days	Waste Load Allocation**	Percent Single-Sample Exceedance Rate	Rolling 30-Day Geometric Mean Exceedance Days
1-3	Weekly	30	0	0	0%	0
O-1	Weekly	30	0	0	0%	0
1-6	Weekly	30	1	0	3%	0
1-8	Weekly	30	2	0	7%	0
1-10	Weekly	30	3	0	10%	25
1-12	Weekly	30	4	0	13%	42
O-2	Weekly	30	1	0	3%	0
MC-2(S1)	Daily	147	**18**	0	12%	1
1-13	Weekly	30	2	0	7%	0
1-14	Weekly	30	1	0	3%	0
1-16	Weekly	30	0	0	0%	0
1-17	Weekly	3	1	0	33%	19
1-18(S2)	Daily	147	**11**	0	7%	41
2-1a	Weekly	30	1	0	3%	0
2-2	Weekly	16	0	0	0%	11
2-4(S3)	Weekly	30	0	0	0%	0
2-7(S4)	Daily	149	8	0	5%	0
3-3(S5)	Daily	150	**43**	0	29%	73
3-4(S6)	Daily	150	7	0	5%	20
3-5(S7)	Daily	150	0	0	0%	0
3-6	Weekly	30	0	0	0%	0
3-8(S8)	Weekly	30	0	0	0%	0
S9*	Daily	149	**12**	-	8%	-
BC-1(S10)	Daily	98	9	0	9%	49
2-10(S11)	Weekly	30	0	0	0%	0
2-11	Weekly	30	0	0	0%	0
2-13(S12)	Weekly	30	1	0	3%	0
*S13**	Weekly	30	*1*	-	3%	-
*S14**	Weekly	30	*1*	-	3%	-
*S15**	Weekly	30	*1*	-	3%	-
S16*	Daily	150	**35**	-	23%	-
*S17**	Weekly	30	*3*	-	10%	-
*S18**	Weekly	30	*0*	-	0%	-

* MS4 sites S9 and S13-S18 are assessed for the MS4 permit only and are not subject to SMBBB TMDL compliance.
** Waste Load Allocation is defined as allowable number of exceedance days.

Station 1-17 exceeded the rolling 30-day geometric-mean 19 times and registered the highest calculated single-sample exceedance rate at 33%. These values can be misleading and may not represent the true water quality conditions of Tuna Canyon SD (1-17) when considering only 3 samples were collected during summer dry periods and that only one sample exceeded water quality standards. As previously indicated, station 1-17 is frequently inaccessible and thus a higher number of samples would have yielded a more comprehensive representation of water quality conditions.

Amongst the daily monitored MS4 only sites, station S16 had the highest single-sample exceedance days with an exceedance rate of 23%; MS4 station S17 had the highest number of exceedance days for weekly monitored sites with a 10% exceedance rate. Overall, 28 stations (85% of monitoring sites) had an exceedance rate equal to or less than 10 percent.

In terms of analyzing exceedances per FIB (Table 6), *E. coli* and/or Enterococcus objectives were the standards most exceeded amongst all compliance monitoring sites; the single exception was MC-2 (S1), which exceeded the *E.coli*-to-total coliform ratio more often than it exceeded other standards. Stations MC-2 (S1) and BC-1 (S10) had the first and second highest total coliform exceedances, respectively. Stations 3-3 (S5) and S16 either had the highest or second highest *E. coli* and Enterococcus. It should be pointed out that neither of these sites, 3-3 (S5) and S16, exceeded the total coliform standards during summer-dry weather periods even though both recorded high single-sample exceedance rates and, in the case of the 3-3 (S5), the highest rolling 30-day geometric mean exceedance days.

Winter-Dry Weather (November 1 – March 31)

SMBBB TMDL compliance stations monitored during winter-dry weather are allocated higher allowable exceedances days compared to summer-dry periods (Table 4). Thus, fewer TMDL stations (ten) exceeded their WLA during winter-dry periods. Stations 3-3 (S5) and MC-2 (S1) had the highest TMDL single-sample exceedance days and rolling 30-day geometric mean exceedance days amongst daily sampled stations. Single-sample exceedance rate computed for station 3-3(S5) (53%) was the highest rate observed for this winter dry-weather period. Station MC-2 (S1) had the second highest single-sample exceedance rate at 30%. Stations 1-12, 2-2, and 2-13 (S12, Imperial Highway SD) had the highest exceedances for the weekly monitored TMDL stations. Station 2-2 yields a 33% single-sample exceedance rate and a rolling 30-day geometric mean exceedance of 120 days, which was the highest geometric mean exceedance total observed for this winter-dry period. However, the high exceedances rate observed at station 2-2 can be misleading, considering this sites is frequently inaccessible to sampling; samples were collected 9 out of a minimum 14 possible weekly sampling days, Stations 1-12 and 2-13 both had 14% single-sample exceedance rates. Stations 1-6, O-2, 1-16, 1-17, 2-1a, 2-4 (S3), and 2-11 did not exceed on any monitoring day. Generally, single-sample exceedance rates recorded for weekly monitoring stations were lower than exceedance rates obtained from daily sampling stations.

Both daily monitored stations S9 and S16 had high single-sample exceedance days amongst MS4 only sites with an exceedance rate of 37% and 49%, respectively. Station S18 was the only weekly monitored MS4 site that had an exceedance day occurrence. Single-sample exceedance rate computed at station S18 was at 14%.

Exceedances per indicator evaluated for winter-dry weather are summarized in Table 6. Stations 3-3 (S5) and S16 had the highest total number indicator exceedances, corresponding to the high exceedance days and exceedance rates observed at these sites. Station 3-3 (S5) exceeded more often for *E. coli*, and station S16 exceeded more often for Enterococcus standards. In a virtual mirror image to summer-dry weather periods, 3-3 (S5) did not exceed total coliform standards while registering the highest percent single sample exceedance rate for a daily sampled TMDL station (Table 3 and Table 4). *E. coli* and Enterococcus were generally the indicators that exceeded most frequently for this winter dry period (Table 6).

Table 4. Winter-Dry Weather, FY 2012-2013 Exceedance Days

Station*	Sampling Frequency	Sample Days	Single-Sample Exceedance Days	Waste Load Allocation**	Percent Single-Sample Exceedance Rate	Rolling 30-Day Geometric Mean Exceedance Days
1-3	Weekly	14	1	1	7%	0
O-1	Weekly	14	1	1	7%	45
1-6	Weekly	14	0	1	0%	0
1-8	Weekly	14	1	1	7%	1
1-10	Weekly	14	1	1	7%	49
1-12	Weekly	14	2	1	14%	57
O-2	Weekly	14	0	1	0%	33
MC-2(S1)	Daily	79	**24**	3	30%	83
1-13	Weekly	14	1	1	7%	46
1-14	Weekly	14	1	1	7%	0
1-16	Weekly	14	0	1	0%	0
1-17	Weekly	2	0	1	0%	0
1-18(S2)	Daily	78	**19**	3	24%	56
2-1a	Weekly	14	0	1	0%	28
2-2	Weekly	9	3	1	33%	120
2-4(S3)	Weekly	14	0	1	0%	20
2-7(S4)	Daily	79	10	3	13%	27
3-3(S5)	Daily	79	**42**	3	53%	109
3-4(S6)	Daily	79	**19**	3	24%	76
3-5(S7)	Daily	79	10	3	13%	0
3-6	Weekly	14	1	1	7%	11
3-8(S8)	Weekly	14	1	1	7%	3
S9*	Daily	79	**29**	-	37%	-
BC-1(S10)	Daily	55	8	3	15%	65
2-10(S11)	Weekly	14	1	1	7%	23
2-11	Weekly	14	0	1	0%	20
2-13(S12)	Weekly	14	2	1	14%	28
*S13**	Weekly	14	*0*	-	0%	-
*S14**	Weekly	14	*0*	-	0%	-
*S15**	Weekly	14	*0*	-	0%	-
S16*	Daily	79	**39**	-	49%	-
*S17**	Weekly	14	*0*	-	0%	-
*S18**	Weekly	14	*2*	-	14%	-

* MS4 sites S9 and S13-S18 are assessed for the MS4 permit only and are not subject to SMBBB TMDL compliance.

** Waste Load Allocation is defined as allowable number of exceedance days.

Wet Weather

TMDL stations BC-1 (S10), MC-2 (S1), and 3-4 (S6) had the highest single-sample exceedance days amongst daily sampled stations during the wet-weather period; yet, only BC-1 (S10) exceeded its wet-weather WLA. Single sample exceedance rates of 78%, 53%, and 52% were recorded at stations BC-1 (S10), MC-2 (S1), and 3-4 (S6), respectively. Weekly monitored TMDL stations with the highest single-sample exceedance days consist of stations 1-6, 1-12, and 2-10 (S11). These stations exceeded their wet-weather WLA and yielded an exceedance rate

50% (Table 5). Both stations 2-2 and 3-8 (S8) had an equal number of exceedance days; however, only station 3-8 (S8) exceeded it wet-weather WLA, which is due to a more stringent WLA. High exceedance rate observed at station 2-2 reflects on only five out of eight possible sampling days for weekly monitored stations. Four stations, 1-8 (Escondido Creek), 1-14 (Las Flores Creek), 1-16 (Pena Creek), and 1-17 (Tuna Canyon) had exceedance rates of 0%, meaning all samples for these stations passed water quality objectives; the remaining stations had exceedance rates of 13% or higher. Overall, single-sample exceedance rates are higher during wet-weather periods than dry-weather periods, which is consistent with the observed higher geometric mean densities for this period.

Table 5. Wet-Weather, FY 2012-2013 Exceedance Days

Station*	Sampling Frequency	Sample Days	Single-Sample Exceedance Days	Waste Load Allocation**	Percent Single-Sample Exceedance Rate
1-3	Weekly	7	1	3	14%
O-1	Weekly	8	1	3	13%
1-6	Weekly	8	4	3	50%
1-8	Weekly	8	0	3	0%
1-10	Weekly	8	2	3	25%
1-12	Weekly	8	4	3	50%
O-2	Weekly	8	1	3	13%
MC-2(S1)	Daily	32	**17**	17	53%
1-13	Weekly	8	2	3	25%
1-14	Weekly	8	0	3	0%
1-16	Weekly	8	0	3	0%
1-17	Weekly	1	0	3	0%
1-18(S2)	Daily	32	6	17	19%
2-1a	Weekly	8	1	3	13%
2-2	Weekly	5	3	3	60%
2-4(S3)	Weekly	8	2	3	25%
2-7(S4)	Daily	31	13	17	42%
3-3(S5)	Daily	31	15	17	48%
3-4(S6)	Daily	31	**16**	17	52%
3-5(S7)	Daily	31	13	17	42%
3-6	Weekly	8	2	3	25%
3-8(S8)	Weekly	8	3	2	38%
S9*	Daily	31	**18**	-	58%
BC-1(S10)	Daily	27	**21**	17	78%
2-10(S11)	Weekly	8	4	3	50%
2-11	Weekly	8	1	3	13%
2-13(S12)	Weekly	8	2	3	25%
*S13**	Weekly	8	*1*	-	13%
*S14**	Weekly	8	*1*	-	13%
*S15**	Weekly	8	*2*	-	25%
S16*	Daily	32	**18**	-	56%
*S17**	Weekly	8	*1*	-	13%
*S18**	Weekly	8	*2*	-	25%

* MS4 sites S9 and S13-S18 are assessed for the MS4 permit only and are not subject to SMBBB TMDL compliance.

** Waste Load Allocation is defined as allowable number of exceedance days.

In recognition that urban and stormwater runoff conveyed by storm drains and creeks is a primary source of elevated bacteria,the SMBBB TMDL allocates a greater number of single-sample exceedance days during wet-weather (Table 5) compared to dry-weather periods, reflecting higher runoff volume during wet weather. Fewer TMDL stations, 5 compared to 10 and 16 for winter-dry and summer-dry periods, respectively, exceeded their WLA. Sampling sites collected during wet-weather are not subject to rolling 30-day geometric mean compliance requirements.

For MS4 stations monitored daily, S9 and S16 had the highest single-sample exceedance days (Table 5). Stations 3-4 (S6) and BC-1 (S10) had the top two highest numbers of exceedances for all water quality objectives combined; BC-1 (S10) in particular had the highest exceedances for total coliform, *E. coli*, and Enterococcus (Table 6). Monitoring sites 3-4 (S6), 3-3 (S5), and S16 had the second highest exceedances for total coliform, *E. coli*, and Enterococcus, respectively. Enterococcus was the indicator that was exceeded the most during this wet-weather period.

Table 6. Exceedances Per Water Quality Objectives (WQO), FY 2012-2013

	Summer-Dry					Winter-Dry					Wet-Weather				
	Exceedances Per WQO[1]					Exceedances Per WQO[1]					Exceedances Per WQO[1]				
Station	Total[2]	E.coli[3]	Entero[4]	Ratio[5]	Total WQO[1] Exceedances	Total[2]	E.coli[3]	Entero[4]	Ratio[5]	Total WQO[1] Exceedances	Total[2]	E.coli[3]	Entero[4]	Ratio[5]	Total WQO[1] Exceedances
1-3	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1
O-1	0	0	0	0	0	0	0	2	1	3	0	1	1	1	3
1-6	0	1	0	0	1	0	0	0	0	0	2	1	3	0	6
1-8	0	1	1	0	2	0	0	1	0	1	0	0	0	0	0
1-10	0	0	4	1	5	0	1	3	1	5	0	1	2	1	4
1-12	0	1	3	1	5	0	0	2	0	2	2	0	5	1	8
O-2	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
MC-2(S1)	**7**	**11**	10	**12**	**40**	**2**	13	**20**	**14**	**49**	5	7	15	4	31
1-13	0	3	0	2	5	0	0	1	0	1	0	0	2	1	3
1-14	1	1	0	1	3	0	0	1	0	1	0	0	0	0	0
1-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-17	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
1-18(S2)	0	2	10	2	14	0	11	16	10	37	0	2	4	3	9
2-1a	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
2-2	0	0	0	0	0	0	0	5	1	6	0	1	3	1	5
2-4(S3)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
2-7(S4)	0	4	6	3	13	0	1	10	2	13	7	6	13	7	33
3-3(S5)	0	**34**	**14**	**12**	**60**	0	**35**	17	**17**	**69**	1	**13**	13	**11**	**38**
3-4(S6)	**3**	5	6	4	18	**6**	**15**	18	**13**	**52**	**9**	**12**	**16**	**10**	**47**
3-5(S7)	0	0	0	0	0	0	1	9	1	11	**8**	6	13	2	29
3-6	0	0	0	0	0	1	1	2	1	5	2	2	2	1	7
3-8(S8)	0	0	0	0	0	0	0	1	0	1	0	1	3	0	4
S9	0	3	**12**	1	16	1	7	**28**	7	**43**	3	4	**16**	6	29
BC-1(S10)	**5**	5	6	4	20	**4**	5	7	4	20	**16**	**14**	**19**	**9**	**58**
2-10(S11)	0	0	0	0	0	0	0	1	0	1	1	1	4	1	7
2-11	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
2-13(S12)	0	0	1	0	1	0	1	2	1	4	1	1	2	2	6
S13	0	0	1	0	1	0	0	0	0	0	1	1	1	1	4
S14	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
S15	0	1	0	0	1	0	0	0	0	0	0	1	2	0	3
S16	0	**22**	**24**	**9**	**55**	1	**21**	**34**	12	**68**	0	8	**18**	7	33
S17	0	0	3	0	3	0	0	0	0	0	0	0	1	0	1
S18	0	0	0	0	0	0	0	2	0	2	0	0	2	0	2

[1] Water quality objectives (WQO) per indicator bacteria as established by the Basin Plan:

[2] *Total coliform limit is 10,000 MPN/mL*

[3] *E. coli limit is 400 MPN/mL*

[4] *Enterococcus limit is 104 MPN/mL*

[5] *Ratio of E. coli/Total coliform is greater than 0.1 when total coliform level is greater than 1,000 org./100mL*

Field Observations

Field observations were recorded for each sampling location and normally were rated using an EMD historical standard rating system, 1=low, 2=moderate, and 3=high. Observations include the materials of sewage origin (MOSOs) or non-sewage origin, any unusual odors of sewage or non-sewage origin, and flow and flow rate (visual rating only) from storm drains, streams, debris, seaweed, tar, and plankton, among others.

Materials of Sewage Origin

Observations of materials of sewage origin (MOSOs), such as plastic goods (tampon inserts), rubber goods (prophylactic rings), and grease particles were recorded during Fiscal Year 2012-2013. There were no incidences of observed MOSOs in Santa Monica Bay for the entire fiscal year.

Storm Drain Flows

Non-point source pollution has been estimated to be the leading cause of water quality deterioration (EPA 2010). Originating from inland, these pollutants are washed into creeks, streams, rivers, and storm drains, which eventually reach the ocean during heavy rains. Storm drains are designed to receive urban and storm water runoff from paved streets, parking lots, sidewalks, and roofs. Urban and storm water runoff, carried to the Bay through the region's massive storm drain systems and few remaining streams, is a serious, year-round concern (Santa Monica Bay Restoration Commission 2008). Out of the 34 sampling stations along the Santa Monica Bay shoreline, 18 stations are associated with storm drain outfalls, 4 are located at a pier, 6 stations are associated with creeks, 4 are open beach sites, and 2 sites are associated with a lagoon.

A summary of storm drain flow data obtained from CLA EMD Santa Monica Bay monitoring sites during FY 2012-2013 is presented in Table 7.

Low-Flow Diversion Devices (LFDs):

Thirteen SMB compliance stations and one observation site, O-5, monitored by CLA EMD are associated with low-flow diversion devices (LFDs). The cities of Los Angeles and Santa Monica and the County of Los Angeles operate a total of 23 LFDs along the Santa Monica Bay shoreline from Castlerock to Dockweiler State Beach, which as of November 1, 2009 began operating during year-round dry weather. These devices are installed at the major storm drain outfalls to prevent storm water runoff from reaching the Santa Monica Bay beach shoreline by diverting the flows to the sanitary sewer collection system for treatment at the Hyperion Wastewater Treatment Plant (Table 7 and Figure 6).

Table 7. Storm Drain flow data for MS4, SMB TMDL stations and observation sites, FY 2012-2013.

Station	Location	LFD In Place	Summer Dry % Observed Flow Days	Summer Dry Avg. Flow[1]	Winter Dry % Observed Flow Days	Winter Dry Avg. Flow[1]	Wet Weather % Observed Flow Days	Wet Weather Avg. Flow[1]
1-3	Open Beach	-	0	0	0	0	0	0
O-1	Creek	No	91	1	79	1	62	2
1-6	Creek	No	3	1	7	1	25	2
1-8	Creek	No	0	0	0	0	0	0
1-10	Creek	No	15	1	88	2	75	2
1-12	Storm Drain	No	97	2	88	2	100	2
O-2	Storm Drain	No	17	1	33	1	25	1
MC-2	Lagoon	No	15	3	68	3	72	3
1-13	Storm Drain	No	19	1	56	1	88	1
1-14	Creek	No	0	0	0	0	33	2
1-16	Creek	No	0	0	13	1	13	1
1-17	Canyon	No	1	1	14	1	23	1
1-18	Lagoon	No	0	0	8	2	0	0
2-1	Storm Drain	Yes	0	0	7	1	25	2
2-2	Storm Drain	Yes	20	1	20	1	45	2
2-4	Storm Drain	Yes	10	2	0	0	13	1
2-7	Storm Drain[2]	Yes	0	0	0	0	39	3
3-3	Pier	Yes	0	0	0	0	13	2
3-4	Storm Drain	Yes	3	2	14	2	48	2
3-5	Storm Drain	Yes	0	0	3	2	26	2
3-6	Storm Drain	Yes	0	0	6	2	25	3
3-8	Storm Drain[2]	Yes	0	0	0	0	0	0
S9	Open Beach	-	0	0	0	0	0	0
BC-1	Storm Drain	No	100	3	100	3	100	3
2-10	Storm Drain	Yes	0	0	0	0	0	0
2-11	Storm Drain	Yes	0	0	0	0	0	0
2-13	Storm Drain[2]	Yes	23	1	0	0	0	0
S13	Storm Drain	No	0	0	0	0	0	0
S14	Pier	No	0	0	7	1	0	0
S15	Pier	No	0	0	0	0	13	1
S16	Pier	No	0	0	0	0	0	0
S17	Storm Drain	Yes	0	0	0	0	13	1
S18	Open Beach	-	0	0	0	0	0	0
O-4[3]	Storm Drain	No	0	0	0	0	-	-
O-5[3]	Storm Drain	Yes	0	0	0	0	-	-

[1] *Average Flow Rate: (0)= no flow (1)=low (2)=moderate (3)=heavy*

[2] *Low Flow Diversion (LFD) owned and operated by the City of Los Angeles*

[3] *Per CSMP, only dry-weather storm drain flow data for observation sites.*

IV. DISCUSSION

Data presented herein, indicates stations 1-12 (Marie Canyon), MC-2 (S1, Surfrider Beach, Malibu), 3-3 (S5, Santa Monica Pier), and S16 (Redondo Beach Pier) as the sites, overall, that are the most impacted by pollution and consequently, the most problematic. Station 1-12 is located in front of Marie Canyon storm drain on Puerco Beach, just downstream of a treatment facility. Although data identifies 1-12 as a problematic weekly monitored site for the second consecutive year, the data also reveals a decrease in single-sample exceedances of 12 to 4 days during summer-dry weather periods compared to FY 2011-2012. The County of Los Angeles has operated a UV filtration treatment facility near this site since October 2007; it is designed to filter and treat as much as 100 gallons per minute of dry-weather runoff (LADPW 2007a). Los Angeles County's treatment facility at Marie Canyon has no sewer line. Instead, the treatment facility treats stormwater through filtration, and returns the cleansed flow to the storm drain. L.A. County is working to fix issues with the filtration system, including sediment diversions to limit inefficient filtration, as well as increasing dry-weather pumping capacity.

Station MC-2(S1), one of the sites with the poorest water quality, is located at Surfrider Beach at the outlet of the Malibu Creek watershed and is mainly affected by flows from Malibu Lagoon. Higher exceedance rates are registered in the winter and wet-weather seasons when the berm of the Lagoon is breached and flows from the Lagoon mix with the wave wash at the shoreline. The watershed where this site is located covers a large area, approximately 105 square miles. There is considerable local activity at this beach, and the lagoon serves as a habitat for numerous bird species, an added source of bacterial pollutants. Surfrider Beach previously has been identified as one of the most polluted beaches in Santa Monica Bay (CLA, EMD 2003). The U.S. Geological Survey (USGS) published results of a study to identify the distribution and sources of FIB in coastal Malibu waters (Izbicki et al., 2012). Onsite wastewater treatment systems (OWTS) in Malibu were suspected as potential sources of FIB to Malibu Lagoon and the near-shore ocean at and around Surfrider Beach. Results from the USGS study did not support this presupposition; the authors speculated that high FIB concentrations in the Lagoon may originate from non-human fecal sources such as birds and the extended survival or regrowth of indicator bacteria. Higher FIB concentrations and a higher occurrence of exceedances during the USGS study were observed during low tides at the end of the rainy season in April 2010. CLA EMD records of visual observation data indicate the berm was breached during this period. A close inspection of the data presented in Figure 12 of the USGS article shows FIB densities generally tended to rise at high tide during the July study period at Surfrider Beach, Puerco Beach and Malibu Colony Beach. Kelp and other debris along the high-tide line may have contributed to the elevated FIB densities during the July study period.

Santa Monica Pier (3-3, S5) houses several food concession stands, restrooms, and parking facilities, as well as a small marine aquarium, and attracts thousands of local visitors and tourists. This location is one of the ten most polluted beaches in the state for multiple consecutive years according to Heal the Bay's 2011-2012 Annual Report Card (HTB 2012). Data from fiscal years 2010-2011 and 2011-2012 demonstrate a considerable improvement in water quality near the pier compared to previous reporting periods. This was a result of multiple implementation projects by the City of Santa Monica to reduce elevated fecal bacterial levels near the pier; these include replacement of a faulty storm drain under the pier to reduce runoff flows onto the beach, upgrades to the pier's storm drain dry-weather runoff diversion system, and several measures to reduce excessive bird populations at the pier in an effort to mitigate bird feces as a contributing source of bacterial contamination (HTB 2012; CSM 2010a and 2010b). Netting under the pier was installed to keep pigeons and other birds from nesting underneath the pier. These improvements were completed under the Santa Monica Pier improvement projects, funded by CBI and/or by Santa Monica voter-approved Measure V. Increases in dry-weather exceedance days during FY 2012-2013, however, suggest a trend reversal. Dry-weather periods from June to December 2012 registered 35 exceedances, whereas 50 exceedances were observed during January to May 2013 dry-weather periods. The discovery of tears within the netting suggests birds were re-nesting under the pier and may be the cause of the increased exceedances (HTB 2013). A possible resolution of this problem may be as simple as routine maintenance of initial implementations.

Station S16 (Redondo Beach Pier) appears to be the site in the southern Bay area most impacted by pollutants. It stands out due to the very low bacterial densities and exceedances found at surrounding sites. Adjacent to a heavily used pier, station S16 is subject to bacterial contamination by way of the pier and flows from an associated storm drain located under the pier. Redondo Beach Pier is populated with large restaurants, food concessions, restrooms, parking facilities, and large local and tourist populace. Historically a problematic site with a high exceedance rate of water quality objectives for fecal indicators, station S16 was included in a supplemental environmental project for the Los Angeles County Sanitation District's resolution agreement Order (R4-2006-040; Model Program for Bacterial Source Identification and Abatement Plan - Redondo Beach Pier Pilot Project). Results from the microbial source tracking project indicate a human source was not likely the cause of bacterial exceedances and that the storm drain and pond that forms under the pier are not contributors of bacterial loading and contamination during dry-weather periods. Sources of dry-weather exceedances at Redondo Beach Pier could be persistence of FIB in the sand; physical parameters such as wind, wave, tide height, and kelp on the sand; and association with the pier (LACSD 2010).

Other stations that registered elevated levels of exceedances and geometric mean densities, but not to the same degree as the above mentioned sites, especially during dry-weather periods, are 1-10 (Solstice Creek), 1-18 (S2, Topanga Canyon SD), S9 (Marina Beach, Marina del Rey Harbor), 3-4 (S6, Pico-Kenter SD), and BC-1 (S10, Ballona Creek, Dockweiler SB). A Source Identification Pilot Program (SIPP) is currently underway at 1-18 (S2) with researchers from Stanford University, UCSB, UCLA, U.S. EPA Office of Research and Development, and the Southern California Coastal Water Resource Project (SCCWRP). They are developing and implementing sanitary survey/source tracking protocols at 12 to 16 of California’s most polluted beaches, including Topanga (Heal the Bay, 2012).

V. CONCLUSION

Assessment of the FY 2012-2013 SMBBB TMDL and MS4 compliance-monitoring stations reveal an overall reduction for all seasons in the total number of single-sample exceedances from 651 in FY 2011-2012 down to 562 for this reporting year. The widest difference is seen in the summer-dry periods; summer-dry FY 2011-2012 recorded 257 total exceedances, whereas summer-dry FY 2012-2013 recorded 166 exceedances.

Due to constant inaccessibility, one station in particular, station 1-17 (Tuna Canyon), should be re-assessed as to the feasibility of inclusion in the monitoring program. This site was proposed for replacement or deletion by EMD in a letter to the Regional Board in September 2009. Station 1-17 was inaccessible to sampling approximately 82 percent of the time and for the days the site was accessible, there was only one exceedance. This site is inaccessible to CLAEMD sample collectors during high tide events, where bacterial densities may be higher than those days when it is accessible (low tide). Although Tuna Canyon does not discharge onto a public beach, it was included in the SMB TMDLs to fulfill the requirement of having at least one compliance location in every coastal watershed (CSMP 2004). Unfortunately, as it is accessible to private beach individuals during high tide and bacterial densities are unknown for these periods, health risks also remain unknown. As is, it is not possible to get a true or better picture of water quality in this area and sampling efforts are wasted; the value of continued monitoring of this site is unknown by this agency. The removal or replacement of this site was not approved by the Regional Board.

The Santa Monica Bay Beaches Bacteria TMDL compliance deadline for the winter-dry weather period became effective on July 15, 2009. The maximum allowable exceedance days during the winter-dry weather period (November 1 – March 31) is one day for shoreline monitoring stations that are monitored on a weekly basis and three days for those with daily monitoring. The City of Los Angeles' compliance approach was to expand the operation of Low-Flow Diversions (LFDs) from the previously implemented summer-dry period (April 1 – October 31) to year-round diversion, excluding wet-weather events. Thus, as of November 1, 2009, the City, as well as the County of Los Angeles and the City of Santa Monica, began year-round operation of their LFDs. There are a total of 23 LFDs installed at major storm drain outfalls along the Santa Monica Bay shoreline within Jurisdictional groups 2 and 3 from Parker Mesa at Castle Rock to Dockweiler subwatershed; eight of the LFDs are owned and operated by the City of Los Angeles (Figure 6). Water quality within Santa Monica Bay has shown improvement in recent years due to these Low-Flow Diversion Programs, the City of Santa Monica's Urban Runoff Recycling Facility (SMURRF), and the efforts of other municipalities within the watershed in implementing several best management practices (BMPs). Heal the Bay reports that eight Santa Monica Bay beaches associated with an LFD received A or B grades this year during both summer- and winter-dry weather (Heal the Bay, 2013).

The City and the County Flood Control District negotiated and finalized a MOA addressing construction, operation, and maintenance of an inflatable rubber dam in the Santa Monica Canyon Channel as part of the new Low-Flow Diversion at this location. The construction of the rubber dam is anticipated to be completed by fall of 2012. The County has allocated $2,000,000 for design and construction of this project. Installation of the inflatable rubber dam will enhance the dry-flow diversion by providing ability to monitor and control the water level remotely via a computer or laptop, which will provide faster response to storm events. The goal is to improve the operational efficiency and reliability, which in turn, should improve the dry-weather water quality compliance at Will Rogers State Beach. The City will continue the process of upgrading its LFDs to increase reliability and capacity in order to improve management of year-round dry-weather flow diversion.

While effective for dry-weather flow, low-flow diversions are not necessarily a viable option for wet-weather flows from storm-water runoff. Most LFDs do not have the capacity to handle large volumes of runoff that contain greater amounts of pollutants during wet weather (Santa Monica Bay Restoration Commission 2010), and, unfortunately, the high pollutant load of wet-weather flow has the capacity to affect beaches that routinely have good water quality. Either the capacity

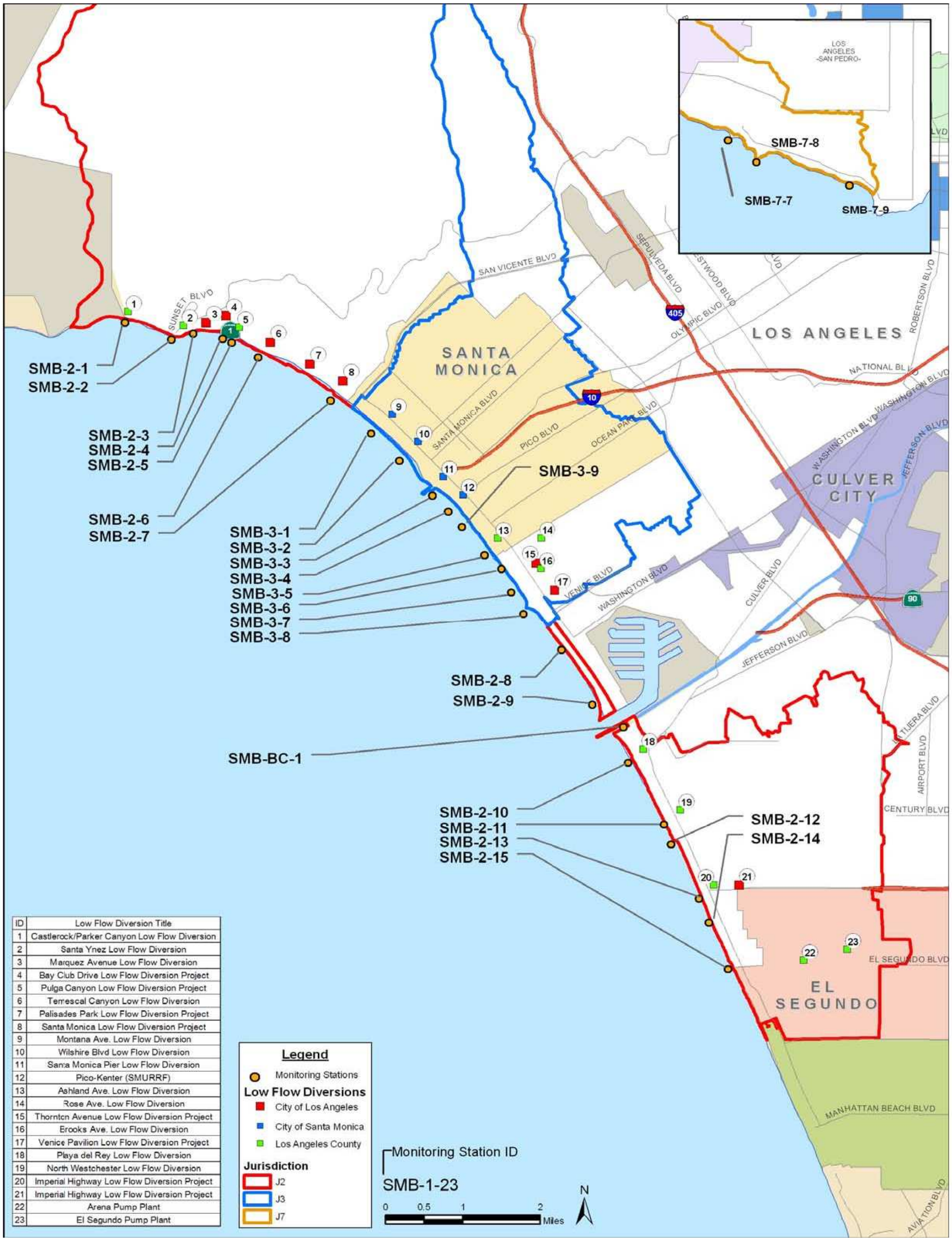

Figure 6. Low-Flow Diversions (LFDs) devices operated by City of Los Angeles, County of Los Angeles, and the City of Santa Monica along the Santa Monica Bay shoreline from Parker Mesa at Castle Rock to Dockweiler subwatershed.

of flow devices must be increased to handle year-round flow, including wet-weather flows, or storm drain flows and runoff to recreational waters must be reduced.

On June 7, 2012, the Regional Board adopted revisions to multiple bacteria TMDLs in the Los Angeles Region (Basin Plan), including the SMBBB TMDLs; the State Water Resources Control Board subsequently approved the Basin Plan amendments March 19, 2013. In 2002, the Regional Board originally adopted a bifurcated SMBBB TMDL, one for dry weather and one for wet weather. The amended 2012 Basin Plan establishes a single SMBBB TMDL addressing both compliance periods. These Basin Plan amendments do not become effective until approved by the State Water Board and until the regulatory provisions are approved by the Office of Administrative Law (OAL). The TMDL revisions must also receive approval from the U.S. Environmental Protection Agency (U.S. EPA).

A few of the amendments that will affect compliance monitoring and reporting include modification to the procedure for calculating the rolling geometric mean, removal of station BC-1 as a compliance site for SMBBB TMDL, and new WLA for winter-dry weather. The current rolling 30-day geometric means, which are calculated daily, shall be replaced by new rolling geometric means that will be calculated weekly using 5 or more samples for six-week periods, starting all calculation weeks on Sunday. As a consequence of the adoption of the Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL (BCB TMDL), BC-1 shall be removed as a compliance monitoring station for the SMBBB TMDL. The future compliance status of this specific location at the mouth of Ballona Creek at Dockweiler State Beach is uncertain because at the same time that the revised SMBBB TMDL removes BC-1, the recently reissued MS4 permit (December 28, 2012; NPDES NO. CAS004001; Order No. R4-2012-0175) incorporates all SMBBB TMDL compliance monitoring sites into the MS4 permit, which essentially replaces all the historical MS4 compliance monitoring stations. As this location has served dual compliance roles as TMDL station BC-1 and MS4 station S10, it is uncertain whether this site will continue to be monitored solely as station S10, cease to exist as MS4 station S10, or possibly be incorporated into another water quality compliance monitoring program such as the BCB TMDL monitoring program.

At the inception of the SMBBB TMDL Coordinated Shoreline Monitoring Plan (CSMP), MS4 shoreline compliance stations were adopted into the CSMP and have served dual roles as MS4 and TMDL monitoring sites. A new winter-dry weather exceedance rate at the reference beach, Leo Carillo, calculated from point zero data collected from November 2004 to October 2010 will increase the final allowable exceedance days for the majority of SMBBB TMDL compliance sites during winter-dry weather. Sites with no change in WLA or that were assigned fewer allowable exceedance days are subject to anti-degradation in which there is no degradation of existing water quality allowed if historical water quality at a particular site is better than the designated reference site.

It is anticipated that the next major milestones in water quality monitoring of recreational waters for the protection of public health will be the implementation of a rapid molecular technique; quantitative polymerase chain reaction (qPCR) currently is the most promising candidate. From a public health perspective, an important facet of qPCR technology is the faster turn around time for results, usually 2-3 hours, compared to the current culture-based test methods requiring 18-96 hours. Quicker turn-around times will permit same-day notifications of the bacteriological condition of recreational waters, which will greatly enhance protection of public health by reducing health risk. The City of Los Angeles' Environmental Monitoring Division (EMD) led a multi-agency qPCR Special Study at select Los Angeles County beaches for the detection of enterococci in the summer of 2011. The study indicated that the qPCR and culture-based bacteriological methods did not correlate well with each other. In addition, there were problems with the presence of inhibition, i.e., chemicals or compounds in the water that interfered with the test results, at a few of the beaches. The correlation discrepancy observed in the 2011 study did not permit the launch of a same-day notification demonstration project in summer 2012 in Los Angeles County as originally planned. As an alternative, CLA EMD, in cooperation with SCCWRP, the Los Angeles County Department of Public Health, and the Los Angeles County Sanitation Districts (LACSD) conducted a follow-up study in the summer of 2012 at six Los Angeles County beaches over a three month period.

Preliminary analysis by CLA EMD of the log-transformed qPCR and chromogenic substrate (CS) data indicates a moderate correlation between methods, $R^2=0.457$, p-value <0.05. Technical modifications by SCCWRP to the qPCR quantification method improved the agreement rate between the methods when both qPCR and CS results did or did not exceeded water quality objectives. False positive rates (qPCR indicated an exceedance of water quality standards when the culture method did not) improved to a low 3% in summer 2012 compared to 16% in summer 2011; a 4% false negative rate (qPCR results indicated no exceedance when the culture method did) was observed in 2012 and an 8% rate in 2011. Inhibition rates also improved; 10% of samples collected in the summer 2012 study exhibited inhibition, whereas the summer 2011 samples had a 15% inhibition rate. This difference could have been greater considering that the one site, Inner Cabrillo Beach, that exhibited chronic inhibition during both studies was dropped after the first week of 2011 study, but was retained for the duration of the summer 2012 study. Final comparison and analysis by SCCWRP of all data sets generated by EMD, SCCWRP, and LACSD is pending. Conclusions ascertained by the final statistical analysis will determine the launching of a demonstration project involving same-day notification of qPCR results to the public and beach visitors.

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